Carrying capacity models for bivalve mollusc aquaculture: consideration of food limitation for growth versus ecosystem ability to process excrement.

## Roger I E Newell

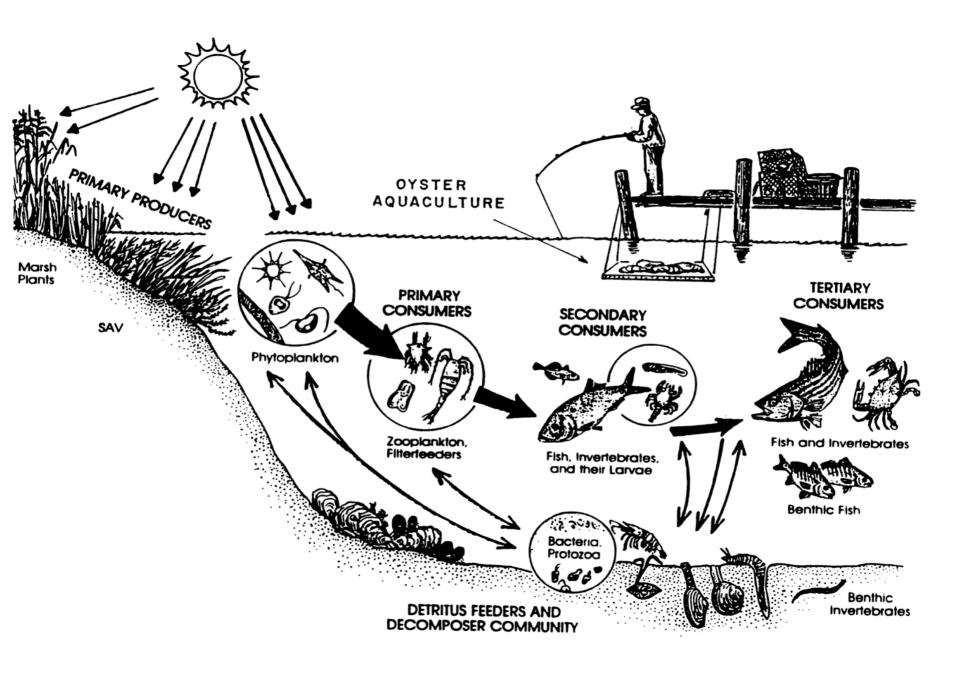
Horn Point Laboratory University of Maryland Center for Environmental Science

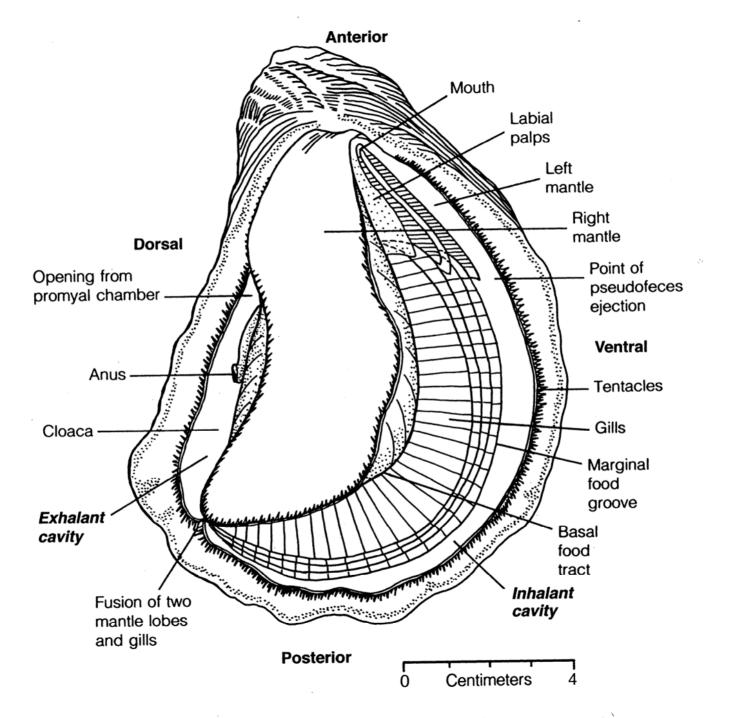
Funding from Maryland Sea Grant Program

"In the context of aquaculture, carrying capacity is generally understood as the standing stock of a particular species at which production is maximized without negatively affecting growth rates."

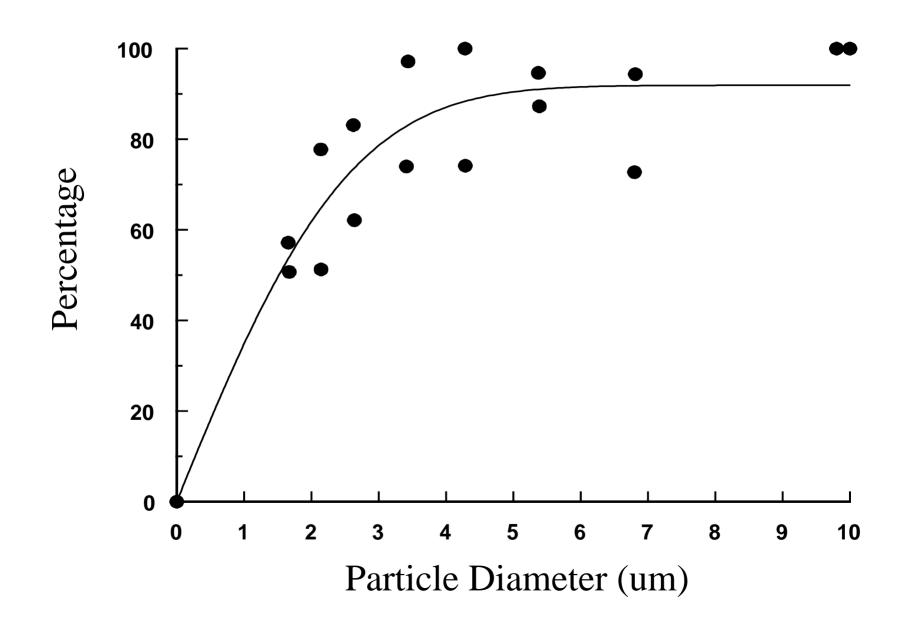
Duarte et al. (2003) Mathematical modeling to assess the carrying capacity for multi-species culture within coastal waters. Ecol. Model: 168:109-143.

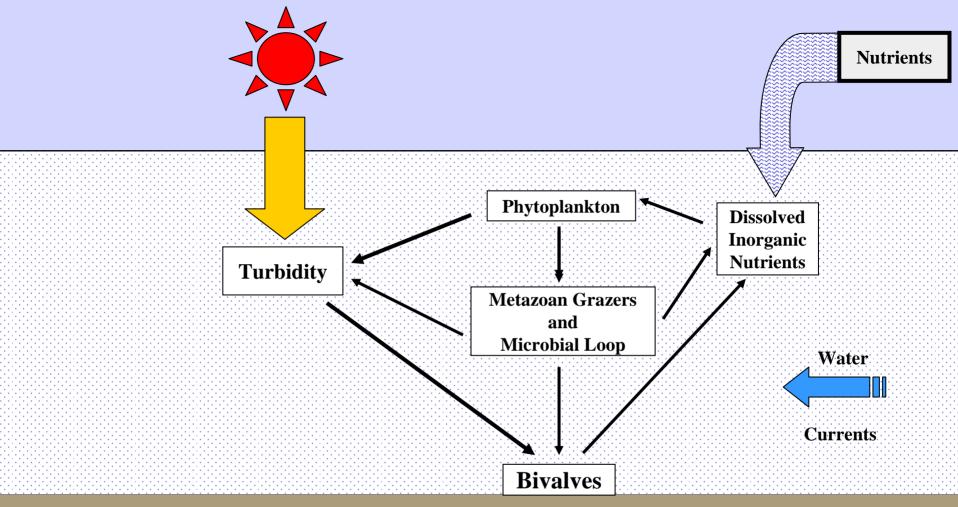
"Carrying capacity is the standing stock of suspension-feeding bivalves where the consumption of phytoplankton, enhancement of nutrient removal, and other ecosystem services are maximized without negatively affecting water quality, sediment biogeochemistry, and overall ecosystem function."





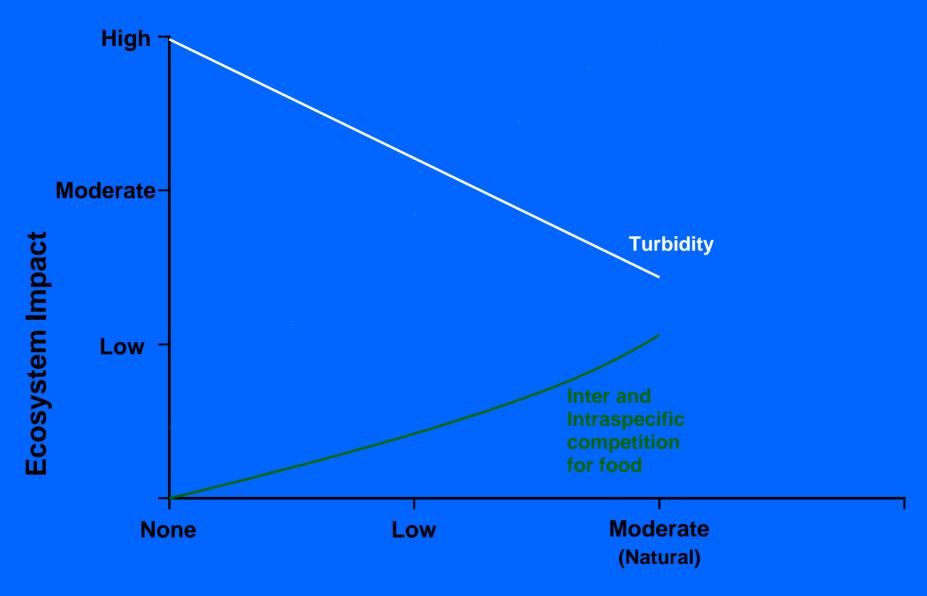
## Particle Retention Efficiency for Crassostrea virginica



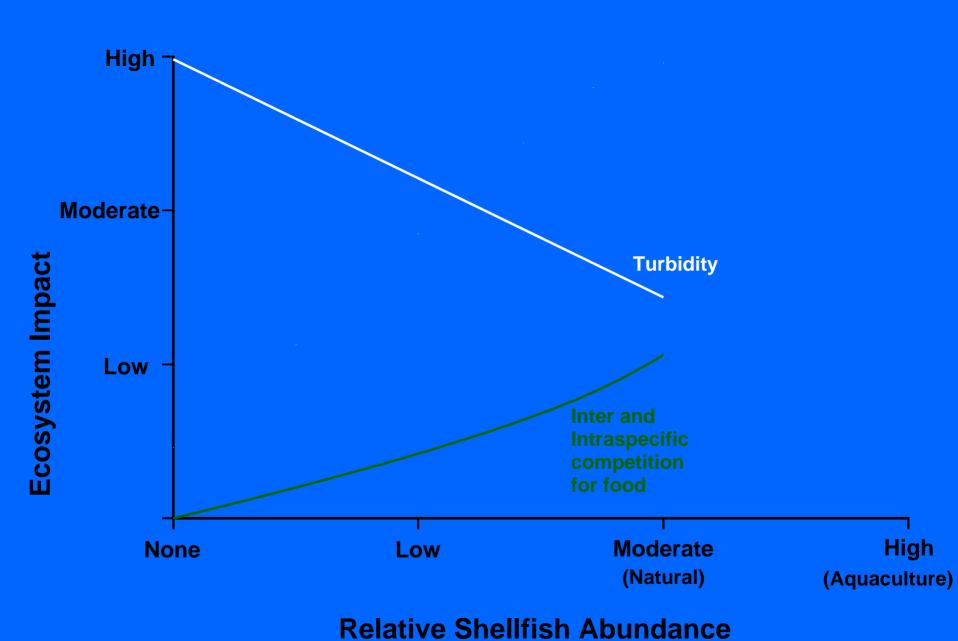


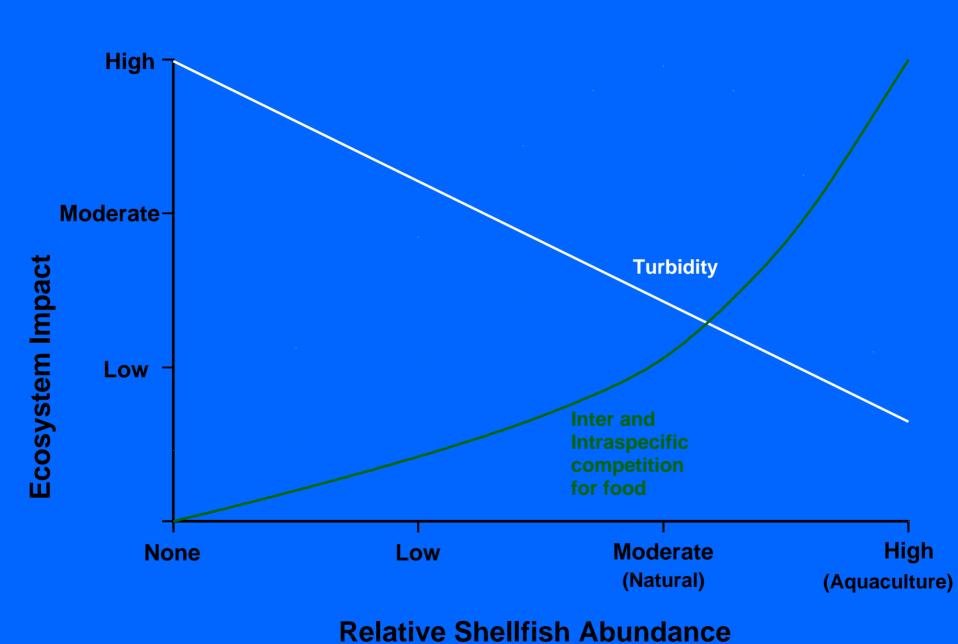
Aerobic Sediment

Anaerobic



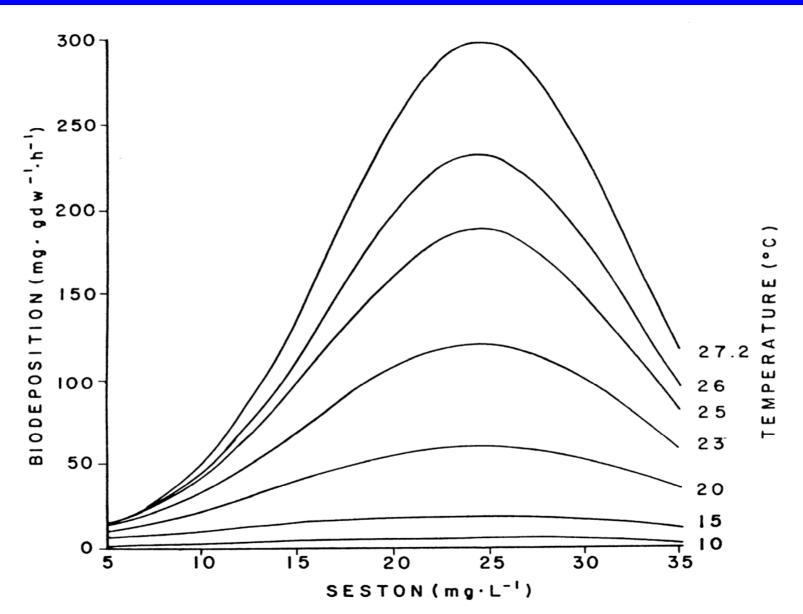
**Relative Shellfish Abundance** 

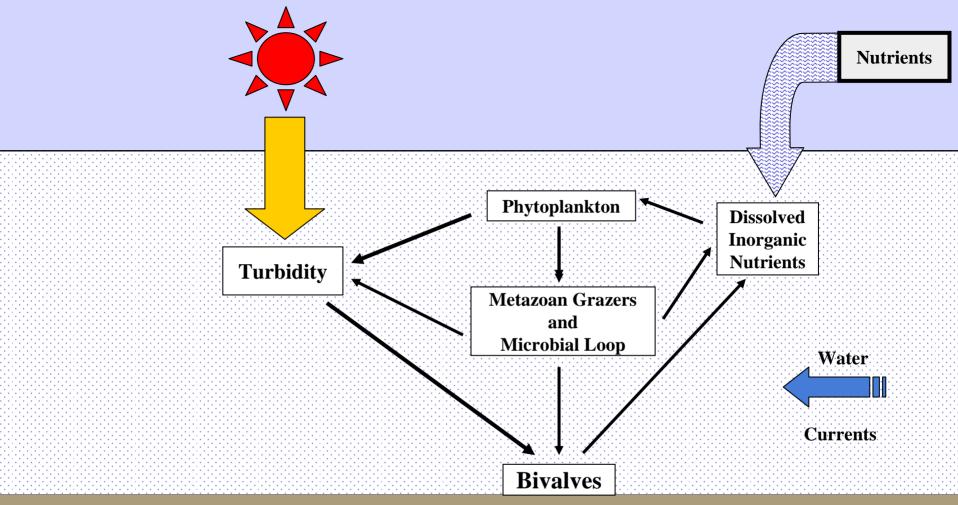




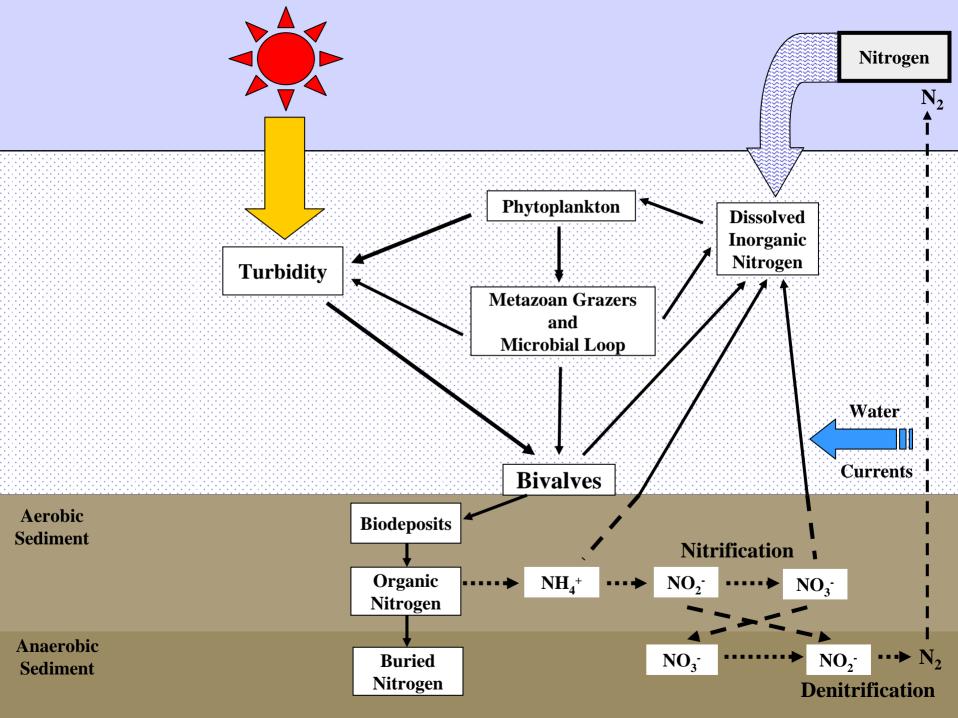


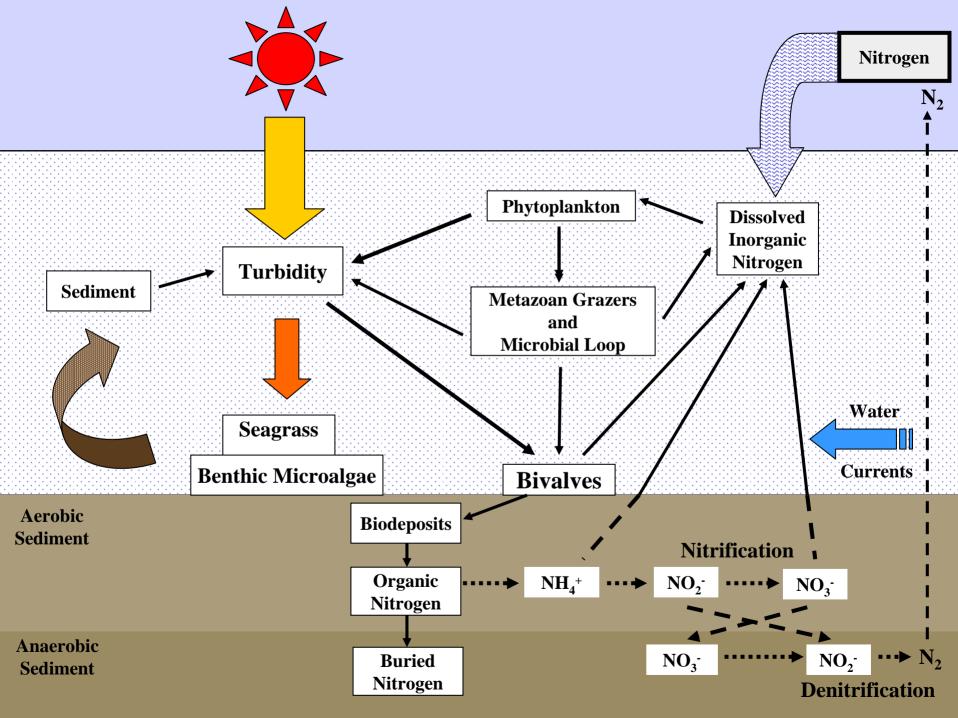
## Oyster Biodeposition Rates (Jordan 1987)

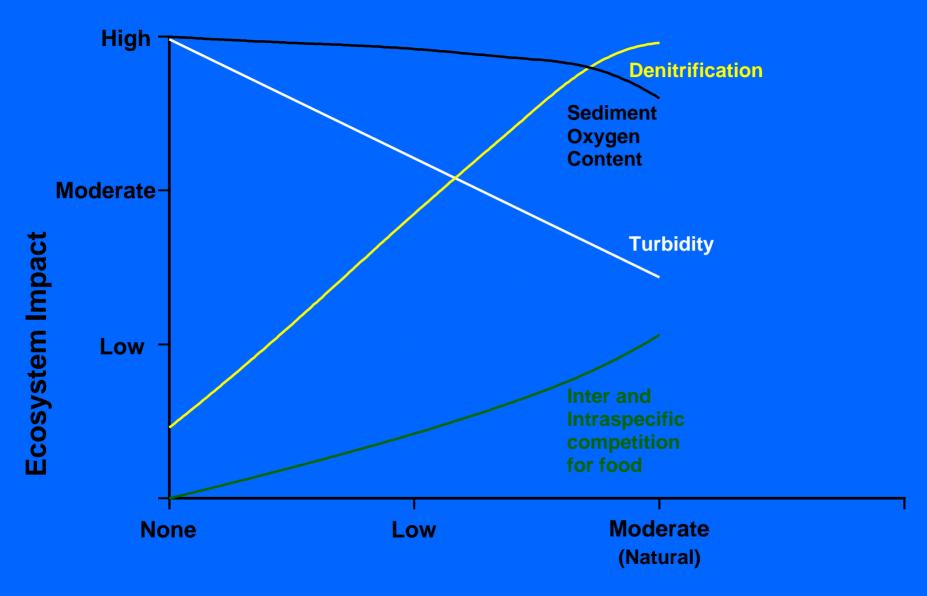




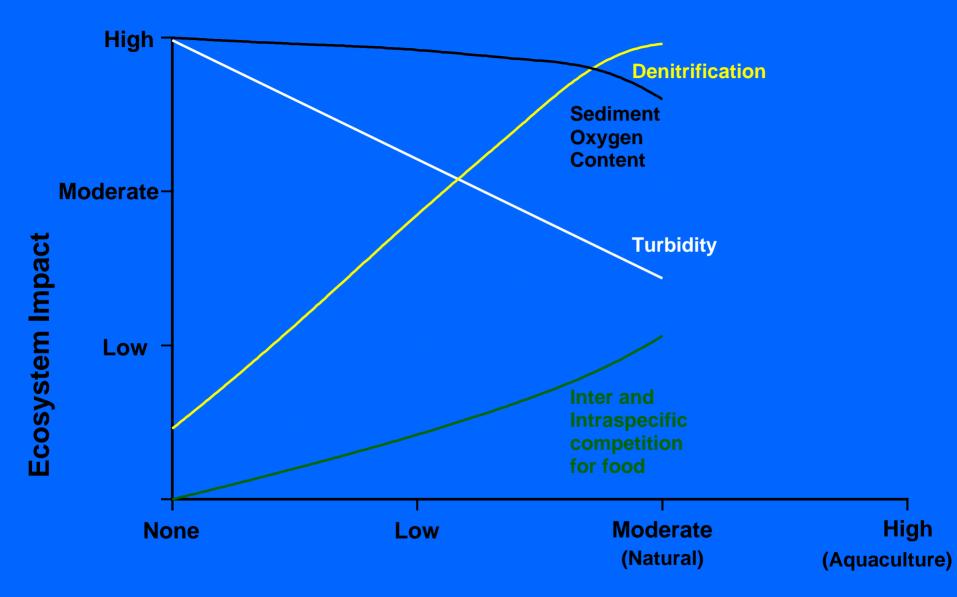
Aerobic Sediment



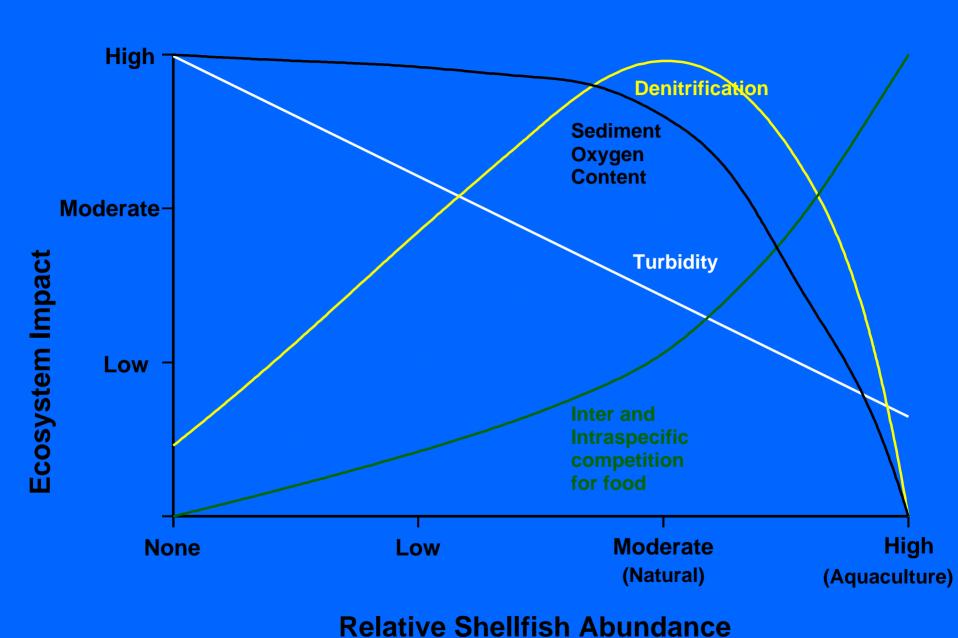


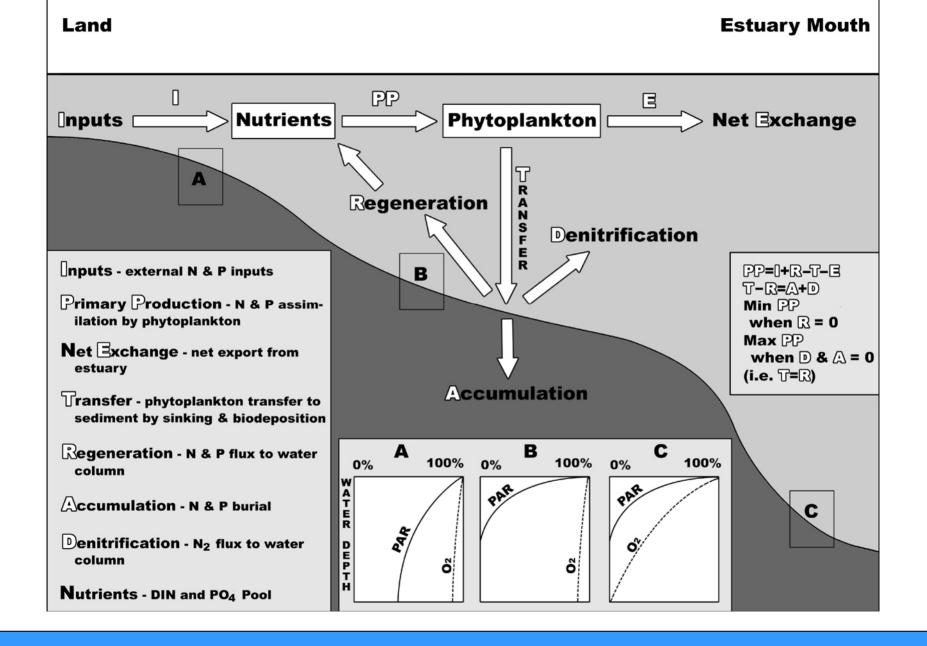


**Relative Shellfish Abundance** 

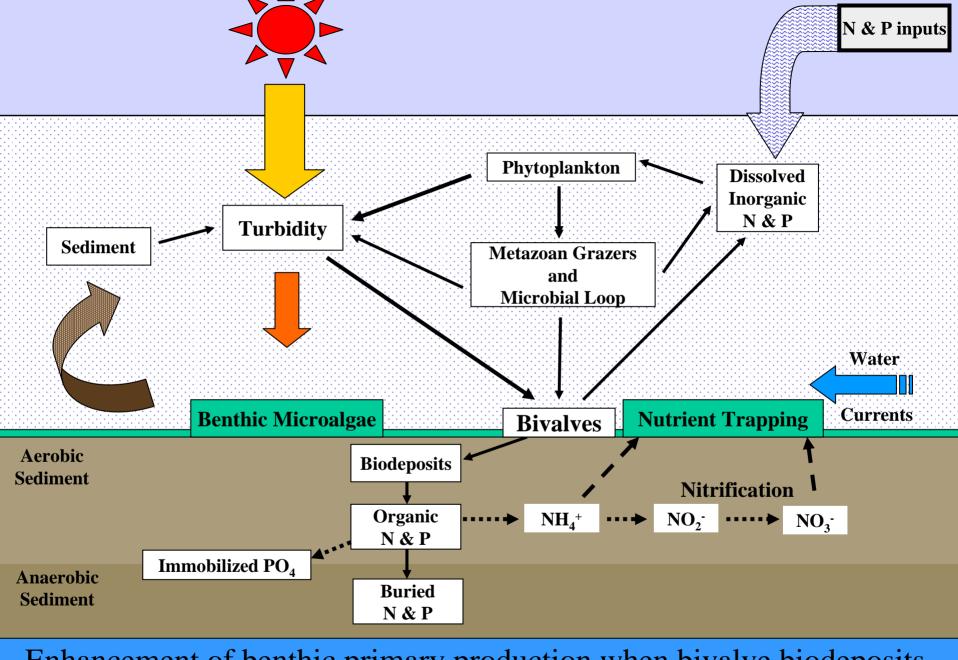


**Relative Shellfish Abundance** 

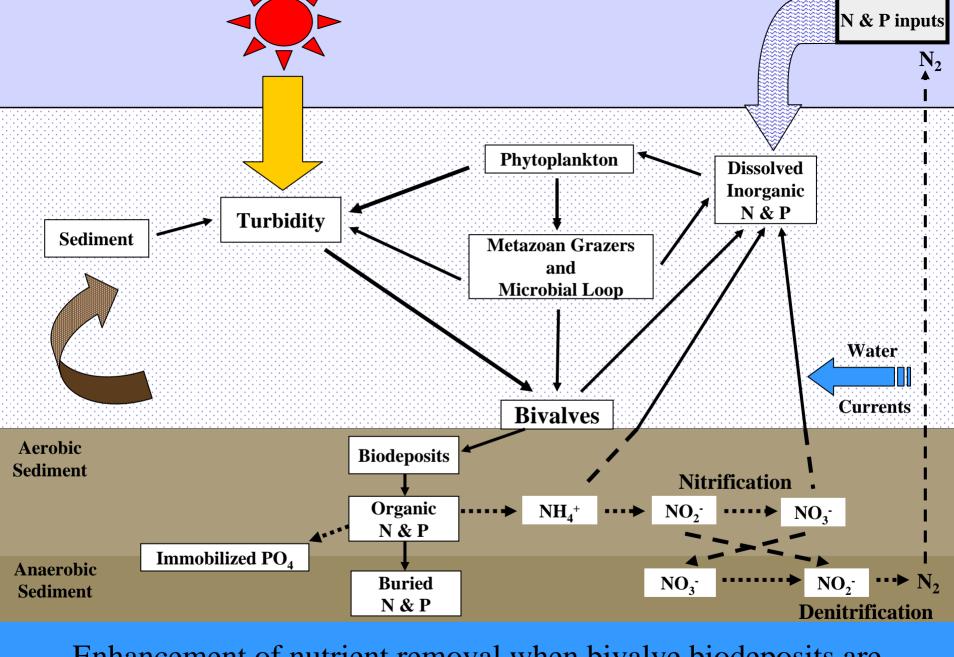




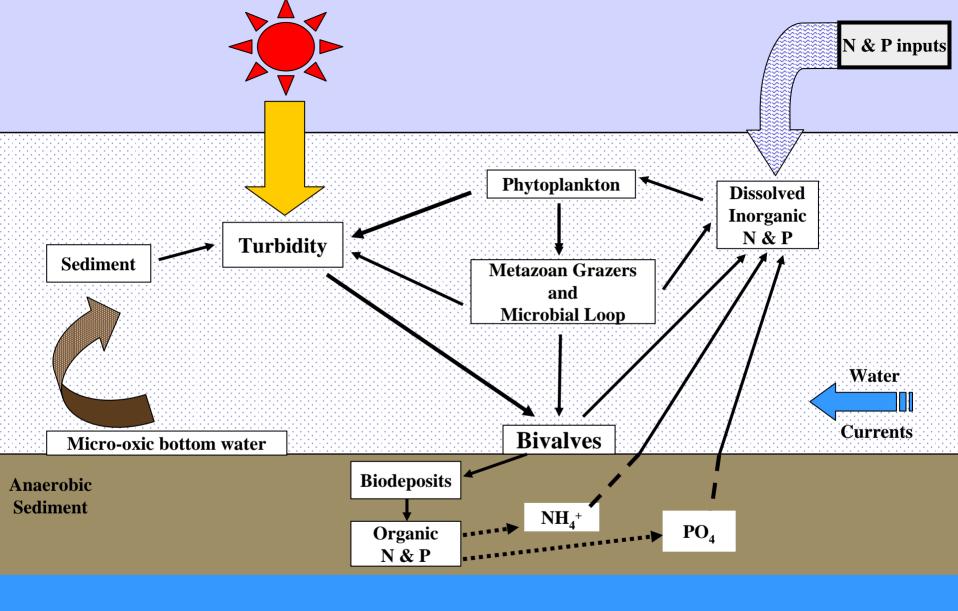
Criteria for correctly positioning bivalve aquaculture in coastal systems



Enhancement of benthic primary production when bivalve biodeposits are processed under aerobic conditions within the euphotic zone



Enhancement of nutrient removal when bivalve biodeposits are processed under aerobic conditions below the euphotic zone



Loss of beneficial ecosystem effects of bivalve aquaculture where biodeposits are transferred to anaerobic sediments



SUMMARY: Incorporating ecosystem effects of suspension-feeding bivalves into multi-species carrying capacity models

Bivalves graze on phytoplankton growing on ambient inorganic nutrients; hence no additional nutrients are introduced as occurs when caged fish are fed food pellets.

Strong seasonality in animal activity alters rates of phytoplankton consumption.

Shift aquatic systems away from pelagic microbial loop to benthic control, and make particulate nutrients available to other benthic organisms.

Biodeposits change sediment geochemistry by enriching sediments; in oxygenated water coupled nitrification /denitrification has the benefit of allowing loss of N as gaseous  $N_2$  and burial of N and P.

## SUMMARY

Bivalve feeding reduces turbidity thereby permitting growth of benthic plants. Beneficial if benthic microalgae and seagrass grow but possible adverse if nuisance macroalgal (e.g., *Ulva* spp) colonize.

Benthic microalgae and bacteria can take up large amounts of N regenerated from bivalve biodeposits

More information required on transport, sinking, and dispersion of bivalve biodeposits under ambient conditions.

Accurate models, incorporating all aspects of bivalve ecological function, will allow managers to make decisions concerning aquaculture placement and resource conservation.